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Using Dynamic Software in Teaching of the Symmetry in Analytic Geometry: The Case of GeoGebra

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Abstract

With the advent of technology in our time, many researches have been conducted and much software has been developed regarding the usability of computers in mathematics teaching. By using GeoGebra which is dynamic mathematics software, this study has aimed to prepare materials about symmetry which is one of the subjects of analytic geometry lesson in secondary education. For that purpose, materials have been formed, which can assist students in taking symmetry of point and line in accordance with coordinate axes, origin, y=x and y=-x lines by paying attention to the directions on the given worksheet, and as a result, internalizing the basic logic of the concept of symmetry.

Keywords: Symmetry, GeoGebra, Dynamic software, Analytic geometry;

1. Introduction

Recent changes in information and communication technology have led the educators to take step towards the integration of computer into education. Having many features, computer is the most preferred and used instrument in education, among the available technologies. However, Flores (2002) stated that although they have amazing features, computers do not work in case of unavailability of quality software. Software prepared in conformity with the acquisitions of education system may contribute to effective learning of the students, by means of in-class practices made under the guidance of teachers. These software that may realized effective learning in mathematics education have highly important position.

Dynamic linking of multiple representations in facilitating students' visualization has an increasing importance due to the fact that students can explore, solve, and communicate mathematical concepts by various methods, such as using dynamic multiple representations and mathematical modeling. Simply providing pictures or figures is not adequate to encourage students to visualize or use various representations (Haciomeroglu, Bu, Schoen, & Hohenwarter, 2009). Software products that can provide this dynamism in mathematics education are available. GeoGebra is one of those software products. As a dynamic mathematics software, GeoGebra can be used for all the subjects of mathematics from elementary education to university; because this software combining algebra, geometry and calculus is highly easy-to-use (Stojanovska & Stojanovski, 2009; Carter & Ferrucci, 2009; Edwards & Jones, 2006; Hohenwarter, Hohenwarter, & Lavicza, 2008).

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Learning the concept of symmetry is expected to be very easy, since we see its examples in some works of art that we use in our daily lives and experience by ourselves in the nature, such as picture and architecture. However, students have difficulty when learning this concept (Aksoy & Bayazit, 2009). In this study, some materials have been developed with intent to enable students to learn the subject of symmetry more easily and to test the correctness of the information constituted by themselves with constructivist approach.

2. Symmetry Teaching with GeoGebra

In this section, information will be given about formation and usage of the materials related to symmetry of the point and line, which can be utilized in analytic geometry teaching.

2.1. Symmetry of the Point

The steps of forming the material, whereby they can see the symmetries to the origin, the x, y-axis, y=x and y=-x of any selected point, are as follows:

i. Open a GeoGebra file

ii.  Form two sliders in such a way as to make the increase amount that you will name as “abscissa” and “ordinate” 1 unit, by using the button (slider button) shown on the left.

iii. Form an A point by writing “abscissa, ordinate” in the input bar.

iv.  By using the button (intersect two objects) shown on the left, form the origin point that is the intersection of the two axis, clicking on the axis x and axis y.

v.  Find the point A_1 that is the symmetry of the point A according to the origin, by using the button (‘reflect object about line’ button) shown on the left.

vi.  Link point A_1 to check box and name the check box as “symmetry to the origin” by using the button (‘check box to show/hide objects’ button) shown on the left. Remove the approval sign after constituting the check box.

vii. Find the points A_2 and A_3 that are the symmetries of the point A according to the axis x and axis y, by using the ‘reflect object about line’ button. For showing and hiding objects, link the points A_2 and A_3 to the check boxes and name the check boxes as “symmetry to the axis x” and “symmetry to the axis y” respectively, by using the check box button.

viii. Form two lines by writing y=x and y=-x in the input bar. Form the points A_4 and A_5 respectively that are the symmetries of the point A according to the y=x and y=-x lines, by using the ‘reflect object about line’ button.For showing and hiding objects, link the points A_4 and A_5 to the check boxes. On the graphics view, remove the condition“show object” by right-clicking on the origin, lines y=x and y=-x.

The GeoGebra material is created by following these steps. Implementation of that constituted material by the students by themselves under the guidance of their instructors, with the worksheet 1 given below, would ensure the formation of correct concept image in the subject of symmetry of the point.

2. 1. 1. Worksheet 1

Open the file “Symmetry1.ggb ” Change the abscissa and ordinate of the point A(x,y) on the screen by use of the sliders, in such a way as to obtain the points required in the table 1. Find individual symmetry values for each point

by using the check boxes, and write them in the suitable fields in the table 1. Reply the following questions after completing the table 1.

Table 1. Symmetries of the Point

THE POINT	SYMMETRIES				
	The Origin	The Axis-x	The Axis-y	The Line y=x	The Line y=-x
(1, 2)					
(3, -2)					
(-1, 4)					
(0, 2)					
(-2, -2)					

✓ What kind of relation is available between the given points and their symmetries that you have taken according to the origin, the axis x, the axis y, the line x=y, the line x=-y? Can you make a generalization?

2.2. Symmetry of the Line

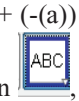
The steps of forming the material, whereby they can see the symmetries to the origin, the x, y-axis, y=x and y=-x of any selected line, are as follows:

i. Open a GeoGebra file

ii.  Form three sliders in such a way as to make the increase amount named as “a”, “b” and “c” 1 unit, by using the button (slider button) shown on the left.

iii. Create a line-d by writing a*x+b*y=c in the input bar. When you write “Line Equation:” + a + "x" + (If[b < 0, "-", "+"]) + (abs(b)) + "y=" + c in the text box that we opened by using the  button, equation of the constituted line will be displayed on the screen.

iv.  By using the button (‘intersect two objects’ button) shown on the left, form the origin point that is the intersection of the two axis, clicking on the axis x and axis y.

v.  Find the point d_1 that is the symmetry of the point d according to the origin, by using the button (‘reflect object about line’ button) shown on the left. When you write “its symmetry according to the origin:” + (-(a)) + "x" + (If[b < 0, "+", "-"]) + (abs(b)) + "y=" + c in the text box that we opened by using the button  , equation of the line d_1 will be displayed on the screen.

vi.  Connect the d_1 equation and the text composed during the step vi to check box and name the check box as “symmetry according to the origin” by using the button (‘check box to show/hide objects’ button) shown on the left. Remove the approval sign after constituting the check box.

vii. Find the d_2 and d_3 equations that are the symmetries of the point d according to the axis x and axis y, by using the ‘reflect object about line’ button.

viii. Connect the lines d_2 and d_3 as well as their equations to the check boxes and name the check boxes as "symmetry to the axis x" and "symmetry to the axis y" respectively, by using the check box button. Remove the approval sign after constituting the check boxes.

ix. Form lines by writing "y=x" and "y=-x" in the input bar.

x. Form the lines d_4 and d_5 that are the symmetries of the line-d according to the lines y=x and y=-x, by using the 'reflect object about line' button.

xi. Connect the lines d_4 and d_5 to the check boxes and name the check boxes as "symmetry about the line y=x" and "symmetry about the line y=-x" respectively, by using the check box button. Remove the approval sign after constituting the check boxes.

xii. As at the step v, connect the text boxes constituted for each equation, which gives their symmetries to the x, y- axis, y=x and y=-x of the line-d, to the check boxes formed at the steps viii and xi.

xiii. On the graphics view, remove the condition "show object" by right-clicking on the origin, lines y=x and y=-x

The view of the GeoGebra material created by following these steps is given in the Figure 1. Implementation of this material by the students by themselves under the guidance of their instructors, with the Worksheet 2 given below, would ensure acquisitions in the subject of symmetry of the point.

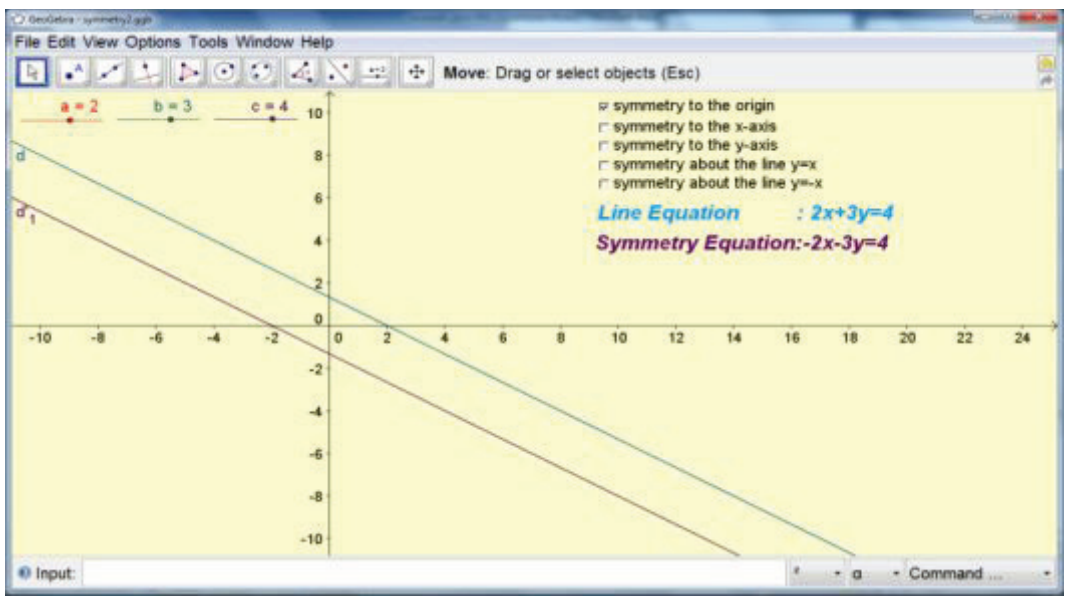


Figure 1. A view of the material-"Symmetry2.ggb" for the line's symmetries

2.2.1. Worksheet

Open the file "Symmetry2.ggb " Make changes on the screen by use of the coefficient sliders of the line d:a * x + b * y = c, in such a way as to obtain the lines required in the Table 2. Find individual equations of the symmetry lines for each line given, by using the check boxes, and write them in the suitable fields in the Table 2. Reply the following questions after completing the Table 2.

Table 2. Symmetries of the Line

THE LINE	SYMMETRIES				
	The Origin	The Axis-x	The Axis-y	The Line y=x	The Line y=-x
x+2y=3					
3x-2y=2					
2x=-1					
3y=-2					
-2x-2y=-3					

- ✓ What kind of relation is available between the given lines and their symmetries that you have taken according to the origin, the axis x, the axis y, the line x=y, the line x=-y? Can you make a generalization?

3. Conclusion and Discussion

Teaching the subject of symmetry in a learning-teaching environment, where GeoGebra as a dynamic mathematics software is used, is believed to be useful in terms of enabling students to learn the subject better. Students would be able to visually imagine the symmetry concept by means of the integration of computer into mathematics. Besides, students would discover what kind of way they need to follow as regards to taking symmetries of the point and line by a constructivist method, by way of their own generalizations. Since students would share with their friends the generalizations that they have reached in consequence of study, a collaborative learning environment would be formed.

Despite the affluence of today's technologic facilities, those facilities cannot be adequately utilized in schools. The teachers teach the lesson by use of traditional teaching methods, which remain insufficient in terms of achieving the aimed targets. In the courses, particularly in the ones having many abstract concepts such as mathematics course, students cannot always focus on the lesson for a long time. By means of the software designed for education, students' interest in the course and their course motivation can be enhanced (Bakar, Ayub, Luan, & Tarmizi, 2010; Tezer & Kanbul, 2009). For this reason, the education researchers may carry out more studies in the field of mathematics education, regarding the subject of computer-aided mathematics education, and consequently may concentrate the attentions of the teachers and educators on this subject.

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